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Using resistant soybean varieties to manage soybean cyst nematode

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Introduction

The soybean cyst nematode (SCN) was a serious yield-limiting pest of soybeans throughout Iowa in 2006. It caused severe damage in areas of Iowa that received less-than-normal rainfall. This nematode is widely distributed throughout the state and does not increase its numbers extraordinarily (i.e. does not flare up) in dry years. The nematode has excellent long-term survival and its population densities build up each year that susceptible soybeans are grown, regardless of the precipitation that occurs. Research in Iowa has shown that up to 40% yield loss can occur without the appearance of any above-ground symptoms.

Life Cycle of Soybean Cyst Nematode

The SCN life cycle begins when the worm-shaped juvenile nematode hatches from the egg. This juvenile cannot develop further until it enters a soybean root and successfully establishes and maintains a feeding site composed of living, but drastically altered, soybean root cells. With adequate nutrition, the hatched SCN juvenile passes through two additional juvenile stages while feeding inside the root before becoming an adult. As SCN females develop, the juvenile stages swell, eventually becoming round or lemon shaped. The fully formed SCN female is as large as the period at the end of this sentence. The female's size causes it to rupture through and be exposed on the surface of the root. Development of SCN males is very similar to that of females until just before the developing males reach adulthood. At that time, the swollen male juveniles revert back into a worm shape, stop feeding, and exit the root to migrate through the soil. Adult males in the soil are attracted to adult females on the root surface by compounds produced by the SCN female, and mating occurs on the root surface. After mating, the SCN females begin to produce eggs. The SCN female first produces approximately 50 eggs outside the body in a gelatinous material to form an egg mass. Once the egg-mass eggs are deposited, additional eggs begin to be retained inside the SCN female body cavity. There will be up to 200 eggs formed within the SCN female body cavity. Eventually, the SCN female dies and her body wall turns tough and leathery to form a protective covering of the eggs called the cyst.

Management Options

For all practical purposes, SCN can never be eliminated from a field once it is present. However, there are things that can be done to manage the nematode in order to maximize soybean yields and minimize reproduction of the nematode. Effective management of soybean cyst nematode involves a three-prong approach of 1) scouting for early detection of infestations, followed by proper use of 2) resistant soybean varieties in rotation with 3) nonhost crops in infested fields. Also, a few soil-applied nematicides are available for management of the nematode. The economics of field-wide application of such chemicals need to be considered before utilizing this management strategy.

The Different Sources of SCN Resistance

Soybean varieties available to growers in Iowa and other states in the Midwest possess resistance genes from one of several breeding lines that are referred to as “sources” of resistance. These sources of SCN resistance are PI (Plant Introduction) 88788, Peking, PI 437654, and PI 209332. Resistance from PI 437654 sometimes is referred to as “Hartwig” resistance. The resistance seems to be controlled by a small number (3 or 4) genes within each source of resistance.

Availability of SCN-resistant Soybean Varieties

Each year, the Iowa State University Extension publication titled “Soybean cyst nematode-resistant soybean varieties for Iowa” lists SCN-resistant soybean varieties available to Iowa growers in late maturity group 0 and maturity groups 1, 2, and 3. The publication also indicates the iron deficiency chlorosis score, relative maturity, glyphosate resistance, and source of SCN resistance for the SCN-resistant varieties. Contact information for the seed suppliers also is included in the publication. There are 743 SCN-resistant soybean varieties included in the publication for use in 2007, 94 in late group 0/group 1, 337 in maturity group 2, and 312 in maturity group 3. Most (90%) of the varieties are Roundup Ready®. The number of SCN-resistant varieties available in the current publication is over 100 more than has ever been available in past years (Figure 1).

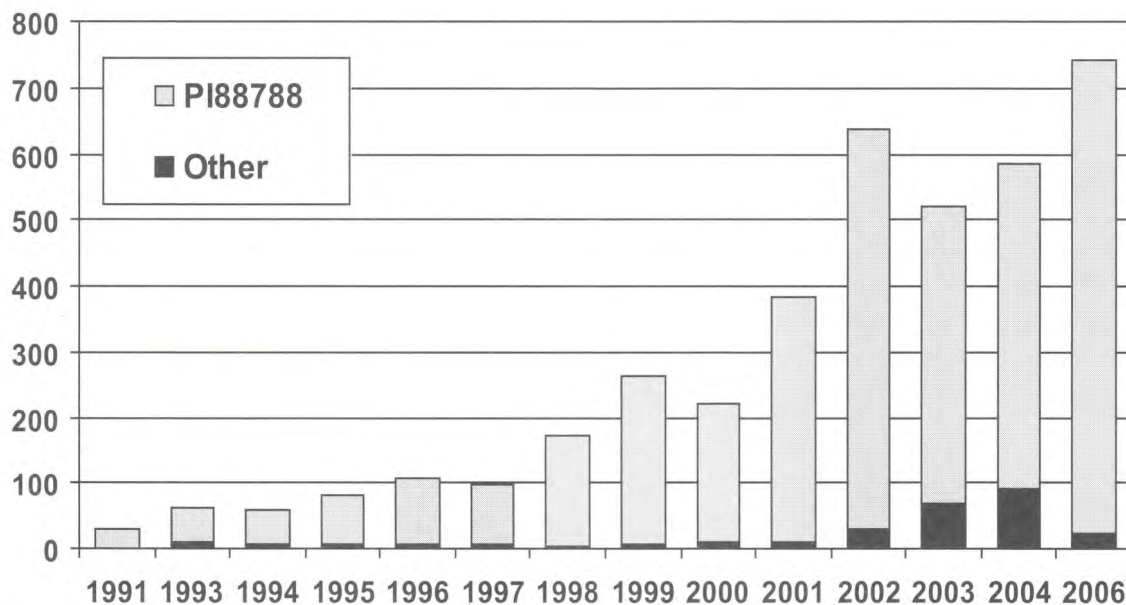


Figure 1. Number of SCN-resistant soybean varieties available for Iowa growers from 1991 to 2006. No data were available for 1992 or 2005. The black portion of each bar indicates the number of resistant varieties with SCN resistance other than PI88788, and the gray portion of each bar represents the number of varieties with SCN resistance from PI88788.

Despite the record-high number of SCN-resistant soybean varieties available to Iowa growers for the 2007 growing season, only 24 of the varieties (or 3%) have SCN resistance from a source other than PI88788. That percentage is down dramatically from 15% of 586 SCN-resistant soybean varieties in 2004.

How Resistance Works

SCN-resistant soybean varieties prevent most SCN juveniles from successfully establishing their feeding site inside the root. Depending on the type or source of resistance the variety possesses, the feeding site may form for a few days then deteriorate, but the end result is the same – the SCN juveniles starve inside the root tissue without a living feeding site being present.

In the soybean industry, resistance to SCN is defined by the number of adult SCN females that form on the roots relative to the number that form on a standard, susceptible soybean variety (usually a variety names Lee 74) in a greenhouse experiment. If a soybean variety supports $\leq 10\%$ of the number of females that form on a susceptible variety, it is considered resistant. If there are $>10\%$ but $\leq 30\%$ of the number of females that form on a susceptible variety, the variety is considered moderately resistant. If the soybean variety supports $>30\%$ but $\leq 60\%$ of the number of females that form on a susceptible variety, it is considered moderately susceptible. Any soybean that supports $>60\%$ of the number of females that form on a susceptible variety is considered susceptible itself.

As defined above, SCN-resistant soybean varieties are not immune to the nematode and, in fact, can support up to 10% reproduction. While this low-level reproduction allows for profitable management of SCN in the field, it does create two possible problems. First, it is not uncommon for SCN-resistant soybean varieties to suffer somewhat reduced yields when grown in SCN-infested fields, particularly if the SCN population density is high. Although yields produced by resistant varieties may not be the best, they will be considerably greater than yields produced by susceptible varieties in SCN-infested fields. Secondly, the low-level reproduction of SCN populations that occurs on resistant soybean varieties allows for selection of SCN populations over time that can successfully reproduce on the resistant varieties or, even worse, on any resistant variety containing the same source of resistance. The number of years it would take for an SCN population to be selected for with elevated reproduction on two different sources of SCN resistance is considerably greater than the time it would take to have to overcome a single source of resistance. So it is critical to have large numbers of soybean varieties with several different sources of SCN resistance for growers to rotate in order to maintain long-term soybean productivity in Iowa.

SCN-resistant varieties produce greater yields than non-resistant (susceptible) varieties and also prevent large increases in SCN population densities in SCN-infested fields. Table 1 contains the average yield of the numerous (>40) SCN-resistant soybean varieties in the Melrose and Churdan, Iowa, locations of the Iowa State University SCN-resistant Variety Trial Program compared to the four SCN-susceptible varieties included in each trial in 2006. The susceptible varieties are “widely grown” varieties from major seed companies. Also in Table 1 are average end-of-season SCN population densities in plots planted with the SCN-resistant and SCN-susceptible varieties at these locations in 2006. At the Melrose location, SCN-resistant soybeans yielded, on average, 4 to 5 bushels per acre more than SCN-susceptible soybean varieties and

there was 6 to 13 times more SCN reproduction on the susceptible varieties than on the resistant varieties. At Churdan, SCN-resistant soybeans yielded, on average, 16 to 17 bushels per acre more than SCN-susceptible soybean varieties, and the susceptible varieties allowed 8 to 14 times more SCN reproduction than the resistant varieties. These data clearly illustrate that SCN-resistant soybean varieties pay economically significant dividends twice – in the form of increased yields and control of SCN population densities.

Table 1. Average yield and end-of-season SCN population densities of SCN-resistant and SCN-susceptible varieties at Melrose and Churdan, Iowa in 2006.

Location and variety type	Yield (bushels per acre)		Final SCN population densities (eggs per 100 cc soil)	
	resistant	susceptible	resistant	susceptible
Churdan				
Roundup Ready®	55.7	40.5	2,460	19,594
conventional	52.2	34.6	1,629	22,568
Melrose				
Roundup Ready®	52.1	46.8	1,762	11,444
conventional	52.2	48.2	936	13,168

Summary

Although SCN is a very damaging, long-lived, and widespread pest of soybeans in Iowa, it is effectively managed if infestations are detected early. Successful management consists of scouting (sampling or digging roots) for early detection followed by use of SCN-resistant soybean varieties in rotation with the nonhost crop corn. SCN-resistant varieties with different sources of resistance should be rotated to reduce the chances of selecting for a SCN population that can reproduce on resistant varieties. Growers who have been managing SCN through use of SCN-resistant soybean varieties for several years should monitor the SCN population densities in their fields to determine if the resistance is losing its effectiveness.

Additional Information

Single copies of the list of SCN-resistant soybean varieties available for Iowa growers can be obtained by calling the Department of Plant Pathology at 515-294-1741 or e-mailing Carla Harris at charris@iastate.edu. Ask for Iowa State University Extension Publication PM 1649. The publication also is on the Internet at www.extension.iastate.edu/Publications/PM1649.pdf.

Field performance data (yields and SCN control) of individual SCN-resistant soybean varieties in the Iowa State University SCN-resistant Variety Trial Program conducted throughout Iowa in from 1996 through 2006 can be viewed at www.isuscnvarietytrials.info.

And additional information about the biology, distribution, and management of SCN is available at www.soybeancyst.info.